JL 3041

Technical Progress Report

For the Period:

April 1, 1991 through June 30, 1991

Prepared For:

Rosebud SynCoal Partnership
Advanced Coal Conversion Process Demonstration
Colstrip, Montana

DOE Contract
DE-FC22-90PC89664

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1.0 Introduction and Purpose

This report contains a description of technical progress made on the Advanced Coal Conversion Process Demonstration Project (ACCP).

The project is a U.S. Department of Energy Clean Coal Technology Project. The cooperative agreement defining the project is between DOE and the Rosebud SynCoal Partnership (RSCP). The RSCP is a partnership between Western Energy Company (WECo), a subsidiary of Entech Inc., Montana Power Company's non-utility group, and NRG Inc., a subsidiary of Northern States Power.

This project will demonstrate an advanced thermal coal drying process coupled with physical cleaning techniques to upgrade high-moisture, low-rank coals to produce a high-quality, low-sulfur fuel. The coal will be processed through two vibrating fluidized bed reactors that will remove chemically bound water, carboxyl groups, and volatile sulfur compounds. After drying, the coal will be put through a deep-bed stratifier cleaning process to effect separation of the pyrite rich ash.

The process will enhance low-rank western coals, usually with a moisture content of 25-55%, sulfur content of 0.5-1.5%, and heating value of 5,500-9,000 Btu/lb by producing a stable, upgraded coal product with a moisture content as low as 1%, sulfur content as low as 0.3%, and heating value up to 12,000 Btu/lb.

The 45 ton/hr unit will be located adjacent to a unit train loadout facility at Western Energy Company's Rosebud coal mine near the town of Colstrip in southeastern Montana. The demonstration plant is sized at about one-tenth the projected throughput of a multiple processing train commercial facility. The demonstration drying and cooling equipment is currently commercial size.

2.0 Project Progress Summary

Design work is over 90% complete and construction is approximately 20% complete. A subcontract has been signed with Stone and Webster Engineering Company for design and construction of the facility.

Facility startup and initial production is currently projected to occur before the end of the calendar year. The project is currently three weeks behind the partnership's accelerated schedule and about one year ahead of the cooperative agreement schedule. Costs are being carefully monitored and the project is currently within its budget.

3.0 Process Description

In general the ACCP is a drying and conversion process using combustion products and superheated steam as fluidizing gas in vibrating fluidized beds. Two fluidized stages are used to heat and dry the coal and one water spray stage followed by one fluidized stage is used to cool the coal. Other systems servicing and assisting the coal conversion system are:

Coal Cleaning
Product Handling
Raw Coal Handling
Emission Control
Heat Plant
Heat Rejection
Utility and Ancillary

The central processes are depicted in Figure 3.1, the Process Flow Schematic.

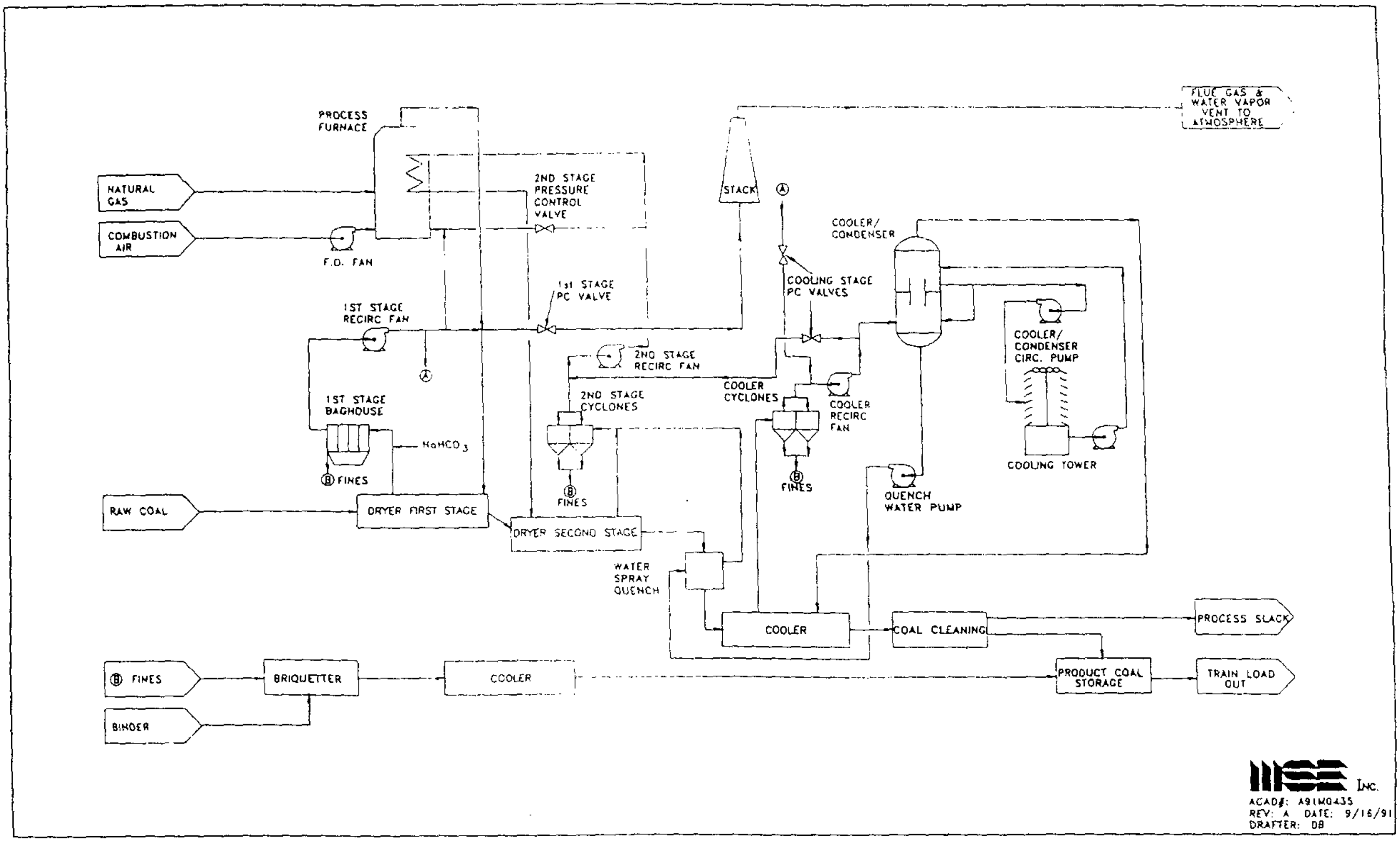
Coal Conversion

The coal conversion is performed in two parallel processing trains. Each consisting of two 5-feet wide by 30-feet long vibratory fluidized bed dryer/reactors in series, followed by a water spray section and a 5-feet wide by 25-feet long vibratory cooler reactor. Each processing train is fed 1,139 pounds per minute of 2 x 1/2 inch coal.

In the first-stage dryer/reactors, the coal is heated using recirculated combustion gases, removing primarily surface water from the coal. The coal exits the first-stage dryer/reactors, at a temperature slightly above that required to evaporate water. The coal exits the fist stage dryer/reactor and gravity feeds the second-stage dryer/reactors, which further heats the coal using a recirculating gas stream, removing water trapped in the pore structure of the coal, and promoting decarboxylation. The water making up the superheated steam used in the second stage is actually produced from the coal itself. Particle shrinkage that liberates ash minerals and imparts a unique cleaning characteristic to the coal occurs in the second stage.

As the coal exits the second-stage dryer/reactors, it falls through vertical coolers where process water is sprayed onto the coal to reduce the temperature. The water vaporized

Figure 3.1



ROSEBUD SYNCOAL
ADVANCED COAL CONVERSION PROCESS
DEMONSTRATION PROJECT-PROCESS FLOW SCHEMATIC

during this operation is drawn back into the second-stage dryer/reactors. After water quenching, the coal enters the vibratory coolers where the coal is contracted by cool inert gas. The coal exits the cooler at less than 150 degree F and enters the coal cleaning system. The gas that exits the coolers is itself cooled by water sprays in contact coolers prior to returning to the coolers.

Three interrelated recirculating gas streams are used in the coal conversion system; one each for the dryer/reactors and one for the coolers.

Gases enter the process from either the natural gas fired process furnace or from the coal itself. Combustion gases from the furnace are used in the first-stage dryer/reactors after exchanging some heat to the second-stage gas stream. The second-stage gas stream is composed mainly of superheated steam. It is heated by the furnace combustion gases in the heat exchanger. The cooler gas stream is made up of cooled furnace combustion gases that have been routed to the cooler loop.

A gas route is available from the cooler gas loop to the second stage dryer/reactor loop. Gas may also enter the first-stage dryer/reactor loop from the second-stage loop (termed make-gas) but not directly into the loop; rather the make-gas is used as an additional fuel source in the process furnace. The final gas route is the exhaust stream from the first-stage loop to atmosphere.

Gas exchange from one loop to another is governed by pressure control on each loop, and after startup, will be minimal from the first-stage loop to the cooler loop and minimal from the cooler loop to the second-stage loop. Gas exchange from the second-stage loop to first-stage loop (through the process furnace) may be substantial because the water vapor and hydrocarbons driven from the coal in the second-stage dryer/reactors must leave the loop to maintain a steady state.

In each gas loop, upstream of the fans, are particulate removal devices to remove dust from the gas streams, protect the fans, and control emissions.

Coal Cleaning

The coal entering the cleaning system from the coal conversion system is screened into four size fractions: plus 1/2 inch, 1/2 by 1/4 inch, 1/4 inch by 6 mesh, and minus 6 mesh. These streams are fed in parallel to four deep-bed stratifiers (stoners), where a rough specific gravity separation is made using fluidizing air and a vibratory conveying action. The light streams from the stoners are sent to the product conveyor; the heavy streams from all but the minus 6 mesh stream are sent to fluidized bed separators. The heavy fraction of the minus 6 mesh stream goes directly to the waste conveyor. The fluidized bed separators, again using air and vibration to effect a gravity separation, each split the coal into light and heavy fractions. The light stream is considered product; the heavy or waste stream is sent to a 300 ton storage bin to await transport to an off site user or alternately back to a mined out pit disposal site. The dry, cool, and clean product from coal cleaning enters the product handling system.

Product Handling

Product handling, consists of the equipment necessary to convey the clean product coal to two 6,000 ton concrete silos and to allow train loading with the existing loadout system.

Raw Coal Handling

Raw coal from the existing stockpile is screened to provide 2 x 1/2 inch feed for the ACCP process. Coal rejected by the screening operation is conveyed back to the active stockpile. Properly sized coal is conveyed to a 1000 ton raw coal storage bin which feeds the process facility.

Emission Control

Sulfur dioxide emission control philosophy is based on injecting dry sorbents into the ductwork to minimize the release of sulfur dioxide to the atmosphere. Sorbents, such as trona or sodium bicarbonate, will be injected into the first stage dryer gas stream as it leaves the first stage dryers to maximize the potential for sulfur dioxide removal while minimizing reagent usage. The sorbents, having reacted with sulfur dioxide, will be removed from the gas streams in the particulate removal systems. A 60 percent reduction in sulfur dioxide emissions should be realized.

A combination of cyclone separators and baghouses are used to control the dust entrained in the coal drying and cooling gas loops. Cyclones are used in the cooler loop and second stage drying loop while duel baghouses are used in the first stage loop. The higher efficiency baghouses are used in the first stage loop because the one route for process gas to atmosphere is from the first stage loop downstream of the baghouses.

Fugitive dust is controlled by placing hoods over the sources to collect the fugitive dust and then pneumatically conveying the dust laden air to fabric filter(s). The bag filters can remove 99.99 percent of the coal dust from the air before discharge.

Heat Plant

The heat required to process the coal is provided by a natural gas fired process furnace. This system is sized to provide a heat release rate of 74 MM btu/hr. Process gas enters the furnace and is heated by radiation and convection from the burning fuel. Process make gas from coal conversion will be used as additional fuel in the furnace.

Heat Rejection

Most heat rejection from the ACCP will be accomplished by releasing water and flue gas to the atmosphere through an exhaust stack. The stack design will allow for vapor release at an elevation great enough that, when coupled with the vertical velocity resulting from a forced draft fan, dissipation of the gases will be maximized. Heat removed from the coal in the coolers will be rejected using an atmospheric induced-draft cooling tower.

Utility and Ancillary Systems

The coal dust that are collected in the conversion and cleaning systems are gathered and conveyed to a surge bin. The coal fines will then be agglomerated and returned to the product stream.

Inert gas will be provided by cooling and drying combustion flue gases. This gas, primary carbon dioxide and nitrogen, will be used principally for baghouse pulse and for makeup gas in the cooler loop.

The common facilities include a plant and instrument air system, a fire protection system, and a fuel gas distribution system.

The power distribution system includes a 15 KV service, a 15 KV/5 KV transformer, a 5 KV motor control center, two 5 KV/480 V transformers, a 480 V load distribution center, and a 480 V motor control center.

Control of the process is fully automated including duel control stations, duel programmable logic controllers, and distributed plant control and data acquisition hardware.

4.0 Technical Progress

4.1 Facility and Equipment Design Engineering and Procurement

During the reporting period, supply contracts were placed for the remaining identified equipment. This included contracts for belt conveyors, mass flow gates, sorbent injection system, steel storage silos, control dampers, fire pumps, loading spouts, control valves, expansion joints, and dust collectors. Table 4.1 lists the equipment supply contracts.

Throughout the reporting period, work continued on general arrangement drawings, piping and instrumentation drawings, foundation drawings, structural steel drawings, electrical drawings, and plant control system programming. Over 21,000 manhours were expended by Stone and Webster Engineering Corporation.

Significant manhours were expended by engineering and purchasing groups in expediting hardware delivery. Conveyor delivery and structural steel erection were identified as critical path items and received special expediting attention.

In June, plant equipment began arriving on the construction site. The vibrating dryers and coolers, raw coal screen, coal cleaning system screen, infeed vibrating feeder, process furnace, direct contact cooler, and the cooling tower were all delivered in June 1991.

Table 4.1 - ACCP Equipment Report

Description	Contractor	Award Date
Coal Dryers/Coolers	Carrier Vibrating Equip.	12/21/90
Belt Conveyors	Willis & Paul	04/01/91
Bucket Elevators	FMC Corporation	03/08/91
Coal Cleaning Equipment	Triple S Dynamics	01/25/91
Coal Screen	Hewitt Robins	12/21/90
Loading Spouts	Midwest International	05/13/91
Dust Agglomerator		
Briquetter Steel		
Silo Mass Flow Gates	SEI Engineers	04/01/91
Vibrating Bin Dischargers	Carman Industries	03/14/91
Vibrating Feeder	Kinergy Corporation	03/22/91
Drag Conveyor		
Process Gas Heater	G.C.Broach Company	01/25/91
Direct Contact Cooler	CMI-Schneible Co.	03/06/91
Dust Collectors	Air Cure Environmental	06/07/91
Air Compressors/Dryers	Colorado Compressor Inc.	03/06/91
Fire Pumps-Diesel	Peerless Pump	05/30/91
Forced Draft Fan	Buffalo Forge Co.	12/21/90
Pumps	Dresser Industries Inc.	03/07/91
Electrical Equipment-4160	Toshiba International	03/14/91
Electrical Equipment-LDC	Powell	03/15/91
Electrical Equipment-MCC	Siemens	03/14/91
Main Transformer	ABB Power Company	01/04/91
Control Panels	Utility Control & Equip. Co.	03/08/91
Control Valves	Applied Control Equipment	05/24/91
Plant Control System	GE Supply Co.	02/08/91
Cooling Tower	JL Herman & Marley	02/01/91
Dampers	Effox Inc.	05/01/91
Dry Sorbent Injec. System	NaTech Resources Inc.	04/19/91
Expansion Joints	Flexonics	05/23/91

4.2 Process Design Topics

One especially important process design effort began in this reporting period.

Dust Handling and Agglomeration

Western coals and especially dried western coals tend to be relatively dusty. This is a very negative characteristic of the upgraded coal and has lead to skepticism and a lack of acceptance of the products in the utility market. The ACCP project team is committed to breaking the mold in this area and producing a product that can be handled with relative ease at the processing facility, in transit, and at the consuming facility.

Because of the gas streams passing through the coal in the driers, coolers, and cleaning equipment, the product coal is "dedusted" which is a positive aspect. The negative side is that a large quantity of dust (6-13 tons/hour) will be collected from the gas streams which must be handled in an economical fashion.

A commercial scale facility might use the dust as fuel in the heat plant. This option was not selected for the demonstration plant due to permitting concerns and the additional cost of a coal fired heat plant. The dust could also be sold as a fuel to an off-site customer. This option is being pursued, but until firm data on production rate and dust characteristics is collected, reliable customers cannot be established and an alternate method of disposable is necessary.

Blending the dust back into the product coal stream or blending and selling the dust with raw coal are both unacceptable alternatives because of excessive problems with fugitive dust emissions while handling the coal.

Burying the dust in mined out pits of the mine is an option but is probably the least desirable both from an economical and resource conservation standpoint.

The only remaining alternative is to convert the dust into a more massive form also called agglomeration. An extensive study of coal dust agglomeration methods was conducted. Enough knowledge was gained to determine which of the methods were the most likely to be successful. Of the four general methods available (pin mixer, disk pelletizer, briquetter, and ring extruder), the products of only briquetters and ring extruders were judged to be strong enough to warrant further pursuit. A bid specification was generated and distributed to vendors. In addition, the option of purchasing used briquetters is being explored.

4.3 Site Construction

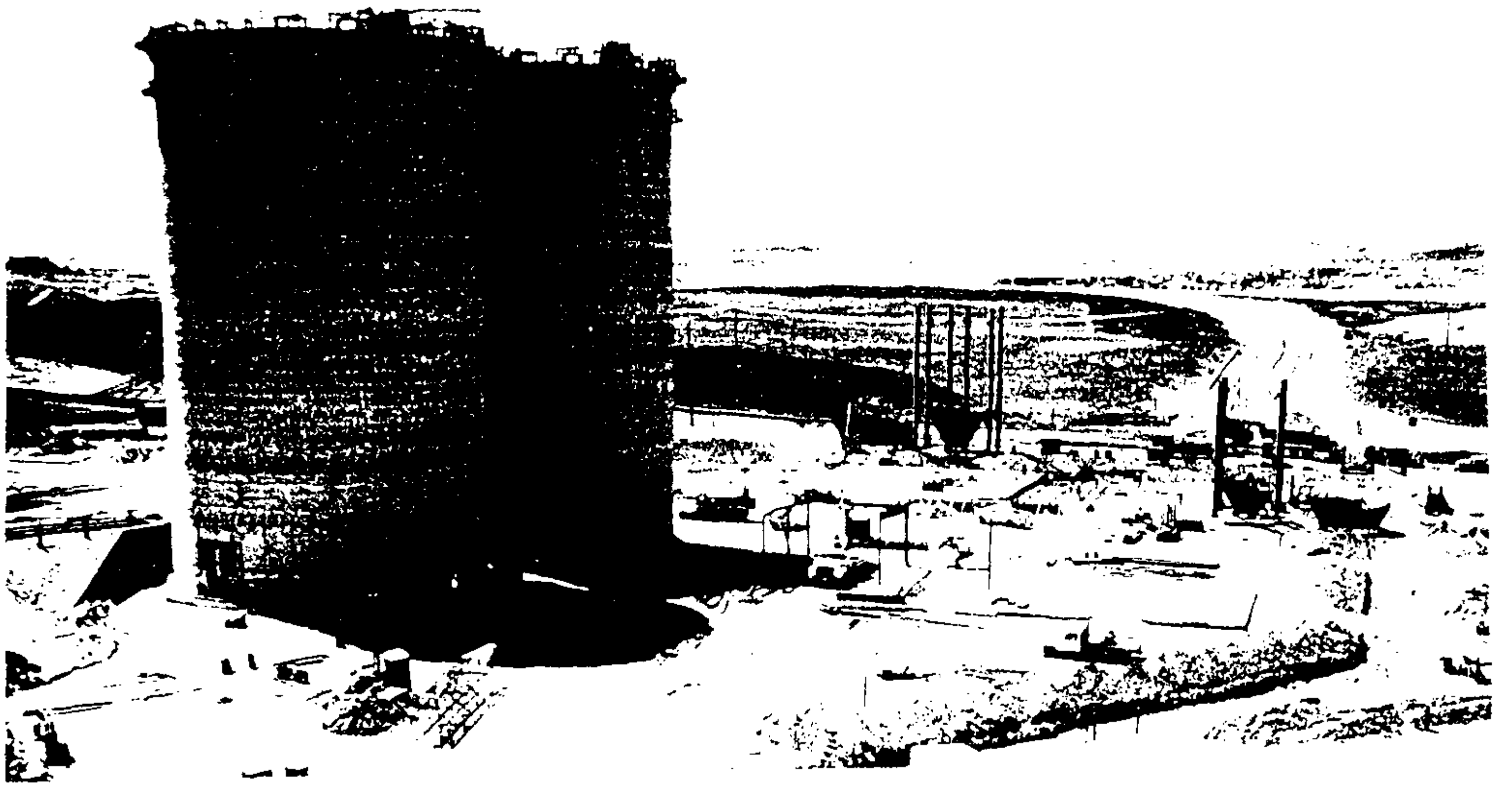
The piling contractor continued work in April, 1991 and was substantially complete May 1, 1991. Fifteen to twenty piles remain to be driven, but exact locations have not been established. The contractor will return to the site in July to complete the work. Five hundred seventy H piles have already been driven. After excess length was trimmed, about 25,650 linear feet remained installed. In addition, about 17,900 square feet of sheet piling has been driven for use as retaining walls.

Foundation work on the concrete storage silos began in late April 1991. In May and June 1991, the concrete mats under the silos were formed and poured followed by construction of the slip forms for the silo walls. About 1,610 cubic yards of concrete were poured in the storage silo foundations, and another 1,718 cubic yards were poured in the silo walls.

Work on the substructure began May 1, 1991. The steel storage silo foundations, in-feed hopper floor, and miscellaneous conveyor bent foundations were formed and poured. Part of the main building structure was also formed and poured and work began on underground piping systems. A total of about 1,770 cubic yards of concrete have been poured by the substructure contractor.

Work on the steel silos began in late June 1991. Erection of the two steel silos consists mainly of welding prefabricated steel pieces at ground level and then hoisting and welding them into place on the structure. A 1,000 ton raw coal storage silo and a 300 ton waste coal storage silo will be erected.

Work on the administration building began in April 1991. Throughout the reporting period, work centered on forming and pouring the foundation for the administration building. The 6,600 square feet administration building contains the facility control room, electrical equipment room, warehouse, office areas, and crew change areas.



ACCP Construction Site
June 1991

4.4 Permitting

Approval of the request for an alteration to the existing air quality permit was not received during the reporting period as expected. Public notice was made by the Montana State Air Quality Bureau of intent to approve the request. Approval notification is now expected in July 1991.

A request for an alteration to the existing mine permit to allow deep-pit burial of the coal cleaning process slack is in processing at the Montana Department of State Lands. A request for further information was received in June 1991. Approval for this alteration is now expected in the fourth quarter of 1991.

4.5 Facility Startup and Testing

Initial operations of the facility are projected for December 1, 1991. Initial startup will be performed by Stone and Webster Engineering.

As part of the initial production period, baseline testing of the process will be performed including compliance monitoring of the particulate removal systems. A test plan will be prepared in the third and fourth quarters of 1991.

4.6 Production and Product Testing

Product production for 1992 is predicted to be 300,000 tons. The product will be sold to utilities and used in controlled test burns. Some initial test burn sales are already ensured. The process for test burns is being formulated and will include procedures for obtaining reportable data.

5.0 Problem Areas and Lessons Learned

No major technical problems are known at this time. Poor weather was the major obstacle to progress during the reporting period. Unusually large amounts of rainfall slowed the substructure and product silo contractors.

Coordination of information between vendors and the engineers has proved to be a problem area and delayed structural steel design efforts.

Delays in establishing a firm plant layout has had a negative effect on preliminary design of conveyors and ductwork.

6.0 Future Work Areas

Work continues on awarding the remaining contracts for equipment and construction. WECo is formulating an operations plan and will begin hiring operators in the third quarter of 1991. Operations and Maintenance (O&M) manuals will be written prior to startup. Methods of obtaining test burn data from the product coal will also be formulated before the end of the year.